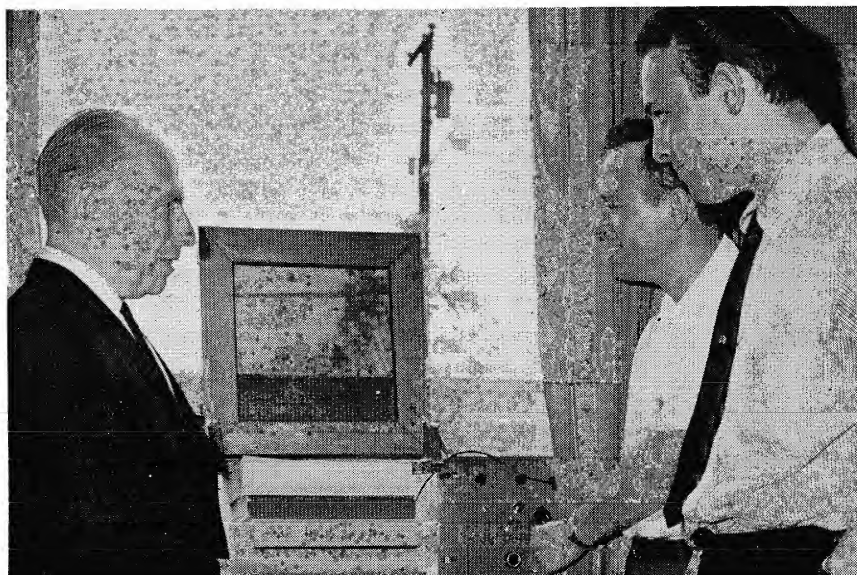




Varad panel in a state of semi-transparency is observed by Alvin Marks, Matthew Forlini, and Neil Weinstein, the men responsible for the invention.



Now you see it—completely clear . . .



. . . Now you don't—it's opaque!

At the click of a switch, glass loses its transparency

Now you see it, now you don't! A flick of a switch literally converts a panel of black glass into a transparent window. The "magic" window is called Varad (*varying radiation*), and its secret is in a fluid sandwiched between two glass panels. Each panel consists of two glass plates between which is a conductive coating (drawing). The fluid contains submicroscopic needle-like particles called dipoles.

The degree of transparency of the

window depends on the suspended dipoles. In the absence of an electrical potential, the particles are randomly distributed and thus block light. But when 400 v ac rms are applied to the conductive coating, the particles are forced to align at 90 deg to the glass panels. The plate thus becomes transparent.

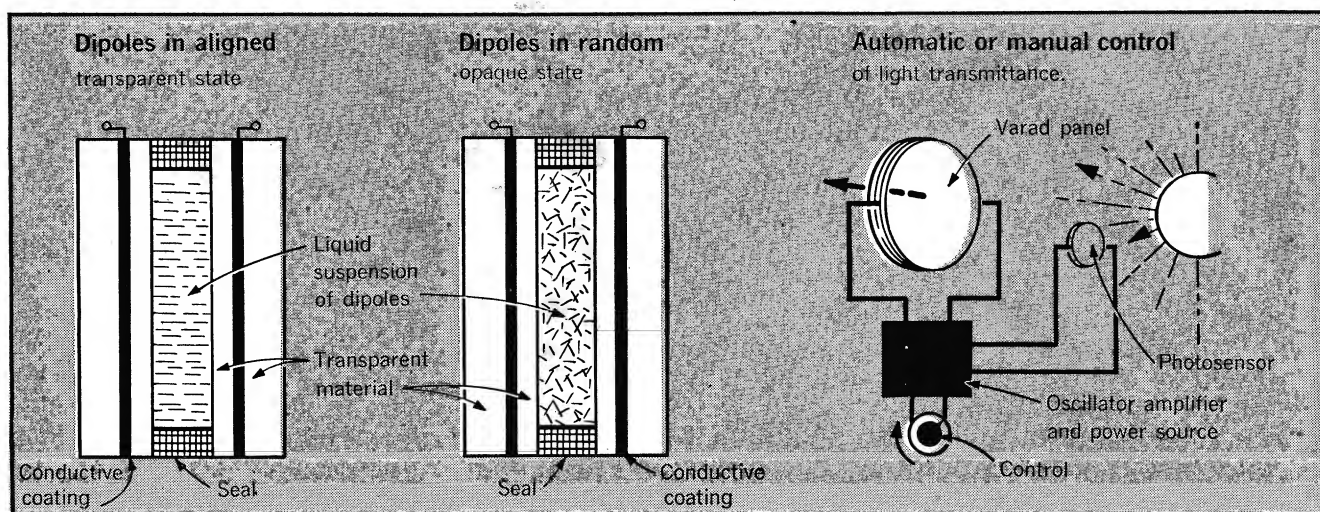
This concept should be distinguished from photochromic, phototropic, or tenebrescent materials that change color reversibly under influ-

ence of light or heat (*PE*—Jan. 31 '66, p 50). This new development in electro-optics is controlled by applications of electric power.

Black and white. Degree of transparency is determined by a control that increases or decreases the electric field. Opening time is 100 microsec to reach ~~63%~~ ^{10% increase in transparency possible} of the final transparency; closing time is 5 millisecc. ~~or less~~ with crossed electric field.

No problem exists with the panel's switching speed, claims Morton Marks, executive vice-president of Marks Polarized Corp. The company is using an organic crystal—herapthite, a compound similar to a polarizer—for the conductive ma-

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Electric potential aligns suspended dipoles (left) so panel can be adjusted to any degree of transmittance (right).

terial. "But we're also working on other materials, especially metals that would perform in the same way," says Marks. One possibility is to make dipoles of dendritic single crystals.

Varad is being researched and developed by Research Frontiers, Inc., 160 Smith St., Farmingdale, N.Y. 11735, and Marks Polarized Corp., New York, N.Y.

Prototypes available. The window can be manufactured in all shapes. Thickness ranges from 2 mm for 1 cm (0.40 in.) dia to 15 mm for 60 cm (24") dia., depending on panel size. Prototypes are available in sizes from 1 cm to 60 cm. Required voltage is 400 v ac rms; maximum voltage from peak to peak is 1700 v. Current per unit area is 0.27 ma/cm². The current is substantially 90 deg out of phase with the voltage, and the load is of nearly infinite resistance. Therefore, negligible power is required.

Ultimately, according to Robert L. Saxe of Research Frontiers, Varad will operate with the voltage

in an ordinary home and a small power pack.

Electrodichroic ratio (the ratio of optical density closed to optical density open at a given applied voltage) is directly proportional to the applied voltage. A Varad panel using 400 v at 25 kc obtains an electrodichroic ratio of 15. Upper and lower ranges of transmittance, depending on dipole layer thickness, for a ratio of 15 are: 63% open, 0.1% closed (DO = 0.2, DC = 3); 50% open, 0.0013% closed (DO = 0.3, DC = 4.5), and 31.5% open, $1.3 \times 10^{-5}\%$ closed (DO = 0.5, DC = 7.5).

Present applications. Research Frontiers is seeking improvement of dipole suspension. At present each dipole is 1 micron long. This is five times as long as the company would like it to be. Ideally, the length should be 25 times the width.

Possible products are: a combined variable-density filter and nonmechanical electro-optical shutter for cameras; goggles and visors to provide control of light from the sun,

from nuclear and other types of explosions, and from arc welding; window and wall panels for buildings to control building temperature as well as light transmittance, and electronic displays including flat panels to replace the standard TV tube.

Future improvements. Developments in photography (controlled contrast, instantaneous pictures, etc), electronic displays, advertising displays, and aircraft and space vehicles (internal temperature control) are planned by the company. In mass production Varad will cost slightly more than ordinary glass. The price of a panel in commercial production is estimated at \$5-\$10/sq. ft.

Varad panels operating on 105-125 v, 60 cycle ac, are available now. Each unit includes a panel, power pack (voltage source, amplifier, oscillator, and frequency and voltage controls) and photocell accessory. A unit 2½ in. square, ⅜ in. thick, costs \$500. A unit 12 in. square, ½ in. thick, is \$1,250, with discounts on quantities. □

RESEARCH FRONTIERS INCORPORATED

160 SMITH STREET, FARMINGDALE, L. I., N. Y. 11735 · TEL.:(516) 293-7880

V A R A D

PANELS AND POWER PACKS

PRICE LIST for SQUARE PANELS*

<u>Catalog Number</u>	<u>Outside Dimensions</u>	<u>Inside Dimensions</u>	<u>Thickness</u>	<u>Price of Panel Plus Power Pack</u>
RV-2	2 1/2" x 2 1/2"	2" x 2"	3/8"	\$ 500.00
RV-4	4" x 4"	3 1/4" x 3 1/4"	3/8"	800.00
RV-6	6" x 6"	5" x 5"	3/8"	1,000.00
RV-12	12" x 12"	11" x 11"	1/2"	1,250.00

The above prices are for one unit, which includes a Panel and power pack. Special discounts will be made for quantities.

The Power pack consists of a voltage source, amplifier, oscillator and controls to vary frequency and voltage. It operates on 105-125 volts 60 cycle AC.

Delivery: 4-6 weeks.

*F.O.B. Research Frontiers Incorporated
160 Smith Street
Farmingdale, L.I., New York 11735

Telephone: (516) 293-7880

RESEARCH FRONTIERS INCORPORATED

160 SMITH STREET, FARMINGDALE, L. I., N. Y. 11735 • TEL.: (516) 293-7880

September 13, 1966

Mr. Theodor H. Nelson
Senior Staff Researcher
Harcourt, Bace & World, Inc.
757 Third Avenue
New York 17, New York

Dear Mr. Nelson:

Thank you for your inquiry concerning the VARAD Panel. This invention is an electro-optical device which enables one for the first time to be able to control and modulate manually and automatically the transmission of light through a window. The invention is in effect, a variable density filter.

You may find the enclosed reprint of an article that appeared in Product Engineering useful in understanding the invention. Our Company holds the exclusive license from Marks Polarized Corporation for this invention. In the near future we expect to sub-license applications of it to larger corporations which will develop commercial products.

At this time, we are selling prototypes for laboratory experimentation and for your information I am enclosing a price list.

Sincerely yours,

RESEARCH FRONTIERS INCORPORATED

Robert L. Saxe

ROBERT L. SAXE
Executive Vice-President

Enclosures: